THE ORDOVICIAN CORAL GENUS *TETRADIUM* DANA FROM NEW SOUTH WALES

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Plates xvii–xxi)

(Accepted for publication 19th August 1970)

Synopsis

Ten species of the exclusively Ordovician tabulate coral genus *Tetradium* are described from New South Wales, including five new species, *T. variabile*, *T. bowanense*, *T. duplex*, *T. cruciforme* and *T. tenue*. Four species in the lower part of the Cliefden Caves Limestone, including very large colonies of *T. cribriforme* (Etheridge), and four different species in the lower part of the Bowan Park Limestone belong to Fauna I of Webby. Two species of *Tetradium* occur in the upper part of the Cliefden Caves succession (Fauna II), the most common being *T. cribriforme*. This latter species is found in the correlative, middle part of the Bowan Park Limestone. Rare fragments of an intermediate species of *Tetradium* have been found in the upper part of the Bowan Park Limestone (Fauna III). A discussion of the classification, stratigraphic significance and distribution of the Australian species of *Tetradium* is presented.

Introduction

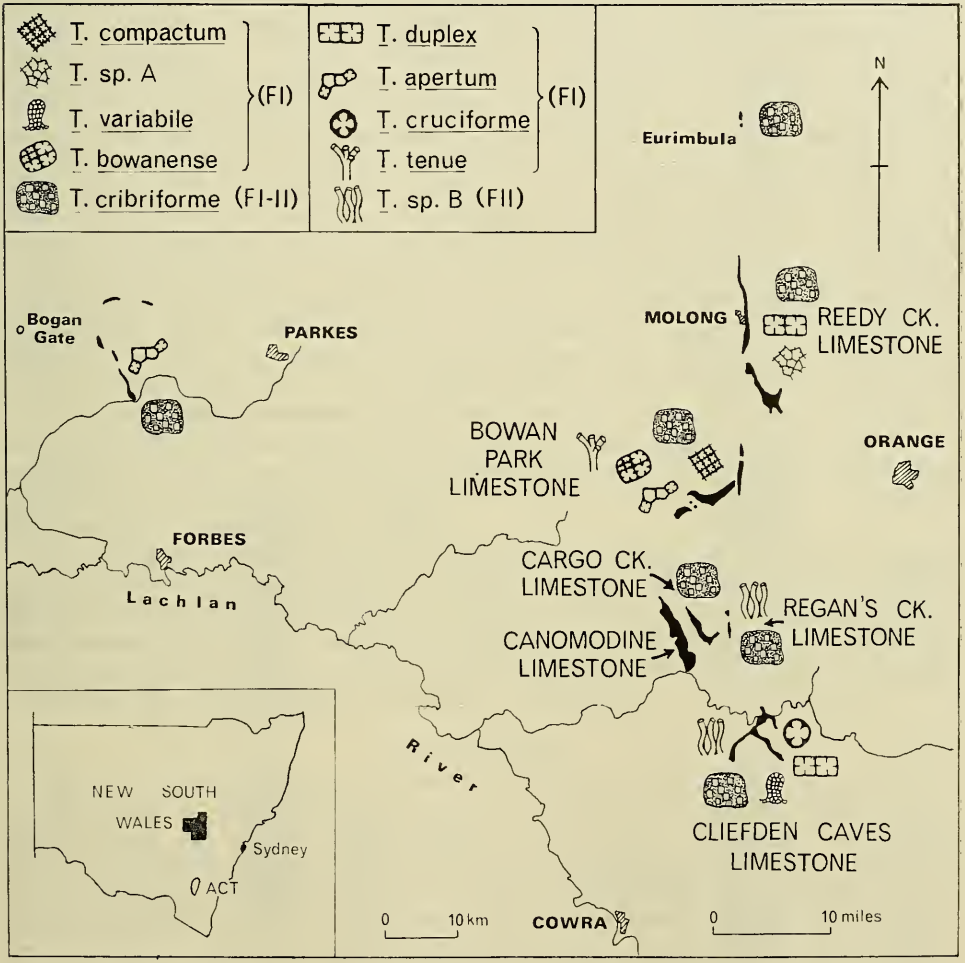
In 1909 Etheridge described a specimen collected by the Rev. J. M. Curran from "limestone in the Parish of Malongulli, on the banks of the Belubula" as *Mitcheldeania* (?) *cribriformis*. Both Ida Brown (1952) and Stevens (1952) mentioned the occurrence of *Tetradium* in the Cliefden Caves Limestone prior to Dorothy Hill's revision (1957) of Etheridge's material and assignment of it to *Tetradium*. Hill reported *Tetradium cribriforme*, *Nyctopora stevensi* Hill and *Propora mammifera* Hill from Fossil Hill, and *T. cribriforme* from a limestone bed in the Malongulli Formation of the Licking Hole Creek area. It seems likely that the type specimen of *T. cribriforme* was originally collected from the Fossil Hill locality because it exhibits the best exposure of large colonies several feet in diameter near the Belubula River, as mentioned by Curran (*in* Etheridge, 1909, p. 311). The reported occurrence in the Malongulli Formation may be questioned, since it has been shown by recent geological mapping in the Licking Hole Creek area that some of the limestone beds shown on Stevens' map (1952, Pl. 3) as occurring within the Malongulli Formation, do in fact lie at the top of the Cliefden Caves Limestone succession. The specimen seems almost certain to have come from the "Island" unit (see Text fig. 2) which is well developed and contains common *T. cribriforme* in the Licking Hole Creek area.

Stratigraphic Distribution

Four species of *Tetradium* occur in the lower, thinly bedded part of the Cliefden Caves Limestone (Text figs. 1–2). The "lower big shell" unit has yielded *Tetradium variabile* sp. nov. and *T. duplex* sp. nov.; the "lower coral" unit is dominated by colonies of *T. cribriforme*; the "upper coral" unit also contains *T. cribriforme*; and the "mixed fauna" unit has *T. cruciforme* sp. nov. and *T. cribriforme*. The predominantly massive, middle part of the limestone

exhibits rare *T. cribriforme,* and it occurs with *T.* ? sp. B (*T. syringoporoides* group) in the "*Aulopora*" unit. The stratigraphically higher "Island" unit also contains moderately common *T. cribriforme.*

The Cliefden Caves Limestone and the Bowan Park Limestone have only one species of *Tetradium* in common, namely, *T. cribriforme,* which is restricted to the middle part of the Bowan Park succession (Text-fig. 2). *T. apertum* Safford has been collected from the "lithic" unit, *T. compactum* Hill, *T. bowanense* sp. nov. and *T. apertum* have been obtained from the

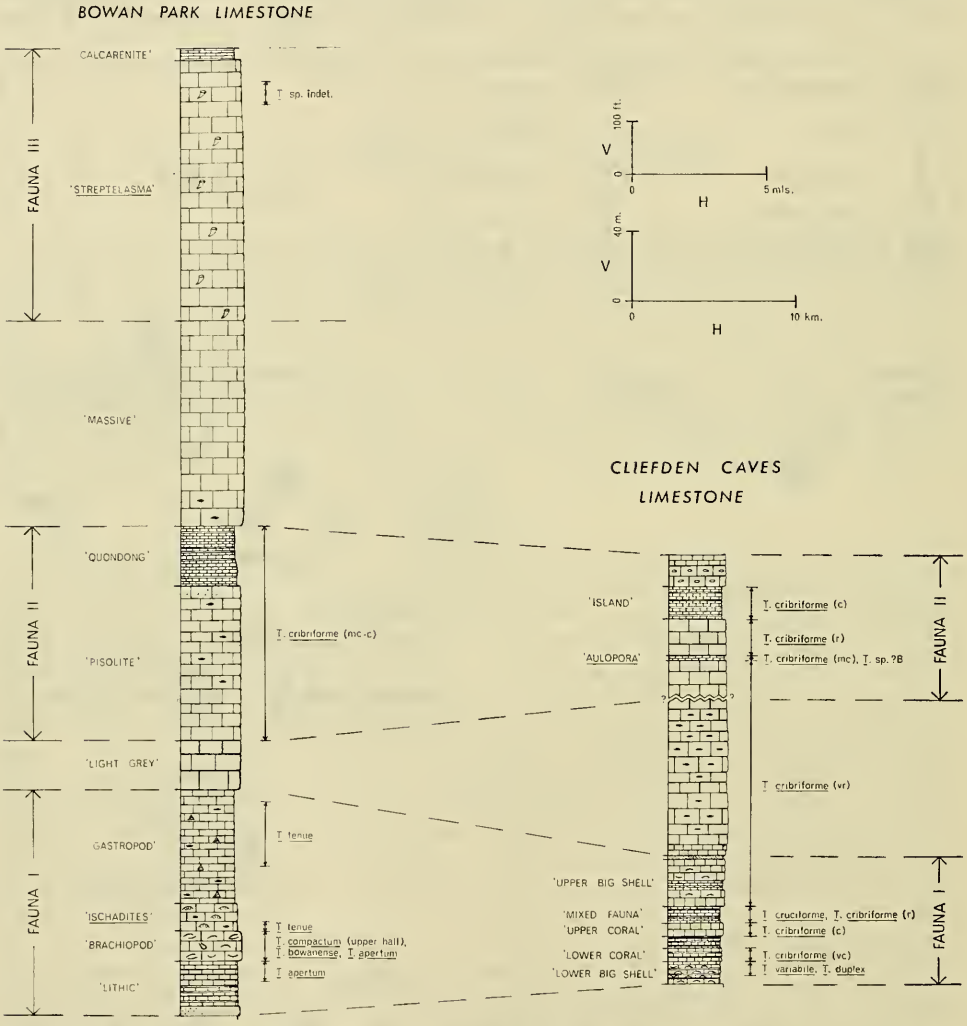


Text fig. 1. Map showing location of main Ordovician limestones of New South Wales and distribution of species of *Tetradium.* FI—Fauna I; FII—Fauna II.

"brachiopod" unit, and *T. tenue* sp. nov. has been found in the lower part of the "*Ischadites*" unit and the "gastropod" unit of the lower part of the Bowan Park Limestone. A larger, *T. syringoporoides*-type coral, up to 3·5 mm. in corallite diameter and exhibiting closely spaced tabulae and quadripartite divisions at widely spaced intervals also occurs in the "gastropod" unit. It may be a new tetradiid genus. *T. cribriforme* occurs in the "pisolite" unit

and the "Quondong" unit of the middle part of the succession. Small, indeterminate fragments of *Tetradium* have also been found recently in the upper part of the Bowan Park Limestone (Text fig. 2).

T. cribriforme has been collected from the middle and upper parts of the Regan's Creek Limestone and *T.* sp. *B* (*T. syringoporoides* type) from a similar horizon to the "*Aulopora*" unit of the Cliefden Caves succession. The



Text fig. 2. Stratigraphical columns of Bowan Park Limestone and Cliefden Caves Limestone showing subdivisions, occurrences and distribution of species of *Tetradium*, and correlation based on stromatoporoid-coral biostratigraphical scheme of Webby (1969). Abundances of *T. cribriforme* (Etheridge) are shown by the following symbols: vr, very rare; r, rare; mc, moderately common; c, common; vc, very common.

lowest beds of the Reedy Creek Limestone exposed to the north of Molong exhibit *T.* sp. A (*T. fibratum* type) and *T.* aff. *duplex*. The succeeding beds contain abundant *T. cribriforme*. *T. cribriforme* has also been collected from the thinly bedded unit ("Quondong" equivalent) in the lower part of the

Cargo Creek Limestone, and from a locality in the Ordovician limestone at Billabong (= Goobang) Creek, west of Parkes (Packham, 1967). *T. apertum* has also been found at another locality west of Parkes, situated to the north side of the railway line just east of Gunningbland (Text fig. 1).

Brief Review of Tasmanian Occurrences

The first species to be described from the Gordon Limestone was *T. tasmaniense* Chapman 1919. It was subsequently restudied by Hill and Edwards (1941) and Hill (1955), and depicted as a ramose form. Although its type locality is given as Smelters Road, Zeehan, it is not common from the Zeehan localities. It occurs abundantly at Queenstown. Further species of *Tetradium* were described by Hill in 1955, including *T. petaliforme* (from Zeehan), *T. compactum* (from Zeehan), *T. dendroides* (common at Zeehan, rare at Queenstown), *T. conjugatum* (from Zeehan and Queenstown), ? *T.* sp. cf. *syringoporoides* Ulrich (from Queenstown) and *T.* sp. (from Zeehan). In Core No. 2 at the Oceana Mine, Zeehan, a true thickness of between 300 and 500 feet of beds was intersected (Hill, 1955). ? *Tetradium* occurs at the base of the core section, *T.* sp., *T. petaliforme, T. compactum* and *T.* ? *tasmaniense* from middle horizons, *T. compactum* and *T. dendroides* from upper-middle horizons, and *T.* ? *compactum* and *T.* sp. from a coralliferous zone near the top. Banks (1957; 1962) mentioned the presence of large colonies of *Tetradium,* 6–8 inches long, preserved in growth position at Zeehan, and the occurrence of *Tetradium* in the "Fenestella Shale" above the Zeehan limestones.

T. ? *compactum, T.* cf. *syringoporoides* and *T.* sp. have been reported from the Gordon Limestone near Ida Bay (Hill, 1955; Banks, 1962), and *T.* cf. *cellulosum* (Hall) from the Florentine valley (Banks, 1965, p. 44). The genus has also been recorded with *"Favistella"* from Gunns Plains, and from Bubbs Hill and Mole Creek (Banks, 1957).

The ramose *T. tasmaniense* is apparently endemic to Tasmania. It does not occur in the Himalayas as Fell (1968, p. 145) has claimed, presumably misled by a typographical error in Bassler's (1950, p. 10) faunal lists. Only one Tasmanian species, *T. compactum* is positively recognized from New South Wales successions. On the other hand, the common New South Wales species *T. cribriforme* does not seem to occur in Tasmania.

Classification

Bassler (1950) proposed a four-fold subdivision of the genus *Tetradium* on the basis of various growth forms: (1) the *T. syringoporoides* group characterized by bushy colonies with long, slender, separated corallites; (2) the *T. cellulosum* group distinguished by separate bundles each consisting of 4 to 16 or more fused corallites; (3) the *T. halysitoides* group characterized by chains and networks of corallites with lacunae; and (4) the *T. fibratum* group typified by having massive, cerioid coralla. It seems a useful division for the purposes of general description and identification, but certain intermediate forms prove to be very difficult to classify using the scheme. For example, Bassler (1950) placed *T buttsi* Bassler in the *T. syringoporoides* group despite the occurrence of incomplete, single, chain-like growths. Its growth form (but not its corallite diameters) closely resembles *T. apertum,* a representative of the *T. halysitoides* group. Others included by Bassler in the *T. halysitoides* group which show only incomplete single chains with bushy form are *T. filitextum* Bassler, *T. gracile* Bassler and *T. pergracile* Bassler. These and *T. apertum* should perhaps be more appropriately placed in the *T. syringoporoides* group. It may be added that Sokolov

and Tesakov (1963) and Klaamann (1966) have grouped *T. apertum* in *Rhabdotetradium,* the genus introduced by Sokolov (1955) to include the species of the *T. syringoporoides* group. Secondly, colonies of *T. variabile* sp. nov. exhibit a wide range of growth form. The exterior of one specimen (SUP 34281) may be mistakenly taken as belonging to the *T. fibratum* group while, at the other extreme, parts of other colonies exhibit discrete bundles of *T. cellulosum* type. The typical (and intermediate) form is of the *T. halysitoides* type—tollinoid habit with irregular lacunae.

Sokolov's (1955) introduction of new genera (and revival of old) for each of Bassler's groups included *Rhabdotetradium* Sokolov (type species *R. nobile* Sokolov) for the species of the *T. syringoporoides* group, *Phytopsis* Hall (type species *P. cellulosum* Hall) for the species of the *T. cellulosum* group, *Paratetradium* Sokolov (type species *T. halysitoides* Raymond) for the species of the *T. halysitoides* group, and a restricted conception of *Tetradium* Dana (type species *T. fibratum* Safford) for the species of the *T. fibratum* group.

The genus *Rhabdotetradium* includes two markedly different morphological forms—the bushy colonies with long, slender, separated corallites, and the "massive" hemispherical to domed sediment-included colonies with close spaced, sometimes linked corallites. The first is strictly of the *T. syringoporoides* type, and the second includes *T. cribriforme* and the type species of *Rhabdotetradium, R. nobile* Sokolov. It is proposed that the "massive" colonies of *T. cribriforme* and *T. nobile* type be assigned separately in the *T. cribriforme* group.

The growth pattern of the ramose *T. tasmaniense,* with corallites intersecting the outer wall of branches obliquely, is clearly quite distinct from that of *T. cellulosum* type with its upright bundles of corallites. *T. tasmaniense* is here referred to a separate group, the *T. tasmaniense* group.

The genera proposed by Sokolov (1955), and followed by Sokolov and Tesakov (1963), Bondarenko (1966) and Klaamann (1966), are based chiefly on different growth form. There is no fundamental difference in the internal morphological features of separate genera. In our opinion growth form is not a sufficient basis for recognizing different genera, unless it can be shown to be independent of local changes in environmental conditions. For the present it seems preferable to abandon the Sokolov genera and reinstate Bassler's informal groupings with the above-stated modifications.

In Australian faunas there are five distinct groups: (1) the *T. fibratum* group, (2) the *T. halysitoides-T. cellulosum* group, (3) the *T. syringoporoides* group, (4) the *T. cribriforme* group, and (5) the *T. tasmaniense* group. The *T. fibratum* group includes massive, cerioid colonies like *T. compactum* and *T. petaliforme.* It has proved difficult to separate the Australian forms of *T. cellulosum* type from *T. halysitoides* type, and consequently they have been combined as the *T. halysitoides-T. cellulosum* group. It consists of irregular, tollinoid forms with lacunae and connected bundles (occasionally isolated) with upwardly-orientated calices. Some of the isolated bundles may have been part of upgrowths from more massive bases. It includes such forms as *T. dendroides, T. conjugatum, T. variabile* and *T. bowanense.* The *T. syringoporoides* group includes bushy colonies with wide, sediment-filled spaces between slender, solitary corallites. The corallites may be dendroid or phaceloid, occasionally cateniform. Examples include *T. cruciforme, T. duplex, T. tenue* and *T. apertum.* The *T. cribriforme* group consists of large, hemispherical to domed "massive" colonies composed of slender, closely spaced corallites, sometimes linked but more often separated by a narrow sediment

infill. The corallites are strictly phaceloid and cateniform. The ramose *T. tasmaniense* group with calices on outer walls suggests that the forms grew as branching upgrowths from the sea floor like a *Thamnopora* or *Parastriatopora* colony.

Stratigraphic Range and Correlation

The earliest records of the genus *Tetradium* are *T. syringoporoides* Ulrich from the Chazyan (possibly the upper) of Virginia (Cooper and Prouty, 1943; Cooper and Cooper, 1946) and the incompletely known, but closely related, species *T. cylindricum* Wilson from the Upper Chazyan of Ontario (Bassler, 1950). The greatest diversity of species is found in the "Blackriveran" faunas of North America. Some 21 species have been reported by Bassler (1950), of which 9 (including *T. filitextum, T. gracile* and *T. pergracile*) belong to the *T. syringoporoides* group, 6 to the *T. halysitoides* group, 5 to the *T. fibratum* group and 1 to the *T. cellulosum* group. In the "Trentonian" some 11 species occur, of which 4 are of the *T. halysitoides* group, 4 are of the *T. fibratum* group, 2 (including *T. apertum*) are of the *T. syringoporoides* group, and 1 is of the *T. cellulosum* group. There is a noticeable decrease in the number of species in the Upper Ordovician of North America—2 species in the Maysville and 4 species in the Richmond. Although there have been suggestions that the genus extended into the Lower Llandovery (e.g., Sokolov, 1962; Sokolov and Tesakov, 1963), it now seems reasonably certain that the last appearance of *Tetradium* is in the uppermost Ashgill, with the species *T. frutex* Klaamann from the Porkuni stage (F_{II}) of Estonia (Klaamann, 1966).

In the lower part of the New South Wales successions (Fauna I of Webby, 1969), there are 4 species (including *T. apertum*) belonging to the *T. syringoporoides* group, 2 to the *T. fibratum* group, 2 to the *T. halysitoides-T. cellulosum* group and 1 to the *T. cribriforme* group. Perhaps the higher proportion of representatives of the *T. syringoporoides* group in this fauna argues for a "Blackriveran" rather than a "Trentonian" age. Fauna II contains 1 species of the *T. syringoporoides* group and 1 of the *T. cribriforme* group, and Fauna III has possibly 1 species of the *T. syringoporoides* group. The decrease in the number of species from a maximum in the "Blackriveran" to a minimum in the Maysville of the North American succession may be roughly complemented by the decrease in the number of species of *Tetradium* from Fauna I (9 species) to Fauna II (2 species) to Fauna III (? 1 species) in New South Wales.

Of the New South Wales species only one, *T. apertum,* is positively assigned to an overseas species. *T. apertum* comes from the Cannon Limestone ("Trentonian") of Tennessee. The occurrence of this species in Fauna I perhaps supports a slightly younger age than "Blackriveran". But, on the other hand, *T. variabile,* also from Fauna I, is closely similar to *T. clarki* Okulitch (especially Bassler's conception of the species) from Lowville strata ("Blackriveran") of Quebec and Ontario.

Systematic Descriptions

Catalogue numbers in the palaeontological collection of the Department of Geology & Geophysics, University of Sydney, have the prefix SUP.

Tetradium compactum Hill, 1955

Pl. xvii, Figs. 1–3

1955. *Tetradium compactum* Hill, p. 244, pl. 1, fig. 12.

1957. *Tetradium compactum* Banks, p. 53, fig. 6.4.

Material: 2 specimens (SUP 29173–4) from the "brachiopod" unit, lower part of the Bowan Park Limestone, Paling Yards Creek.

Description: Massive, cerioid corallum at least 120 mm. across and 70 mm. high. Corallites from 0·5 to 1·0 mm. in diameter; mature corallites with septa from one-half to two-thirds of radius, and average diameters of 0·7 to 0·9 mm. Corallites mainly 4-sided and subrounded in outline with rather thick walls, especially at corners. Wall from 0·03–0·1 mm. thick, usually 0·05–0·07 mm. Layering of tissue in some thicker-walled corallites, with thin outer dark zone and thick inner fibrous zone; orientation of fibres at right angles to corallite wall and septa. Development of layering not uniform in all corallites of particular colony; perhaps of secondary origin. Well developed septa in mature corallites, with marked axial taper. Rare tabulae.

Remarks: The material from Bowan Park closely resembles the holotype of *T. compactum* from Zeehan, and is therefore assigned to it.

Another species of the compact, cerioid *T. fibratum* type occurs in the lower part of the Reedy Creek Limestone (Pl. xvii, figs. 4–5). Although not especially well preserved, it shows far less prominent septa, more angular corners of corallites and thinner walls (0·03–0·05 mm.). Also, a few corallites exhibit small secondary septa (Pl. xvii, fig. 5). It probably represents a new species, but for the present is referred to *T.* sp. A.

Tetradium variabile sp. nov.

Pl. xvii, fig. 6; Pl. xix, figs. 5–8

Material: 8 specimens (SUP 29143–4, 29147–8, 29239–40, 33230, 33238, 34281) from the "lower big shell" unit, lower part of the Cliefden Caves Limestone, Fossil Hill.

Holotype: SUP 29239. Other numbered specimens designated paratypes.

Description: Corallum of irregular to ovoid, usually linked, upright branches, mainly from 4–7 mm. in diameter; in extremes from bundles as little as 3 mm. across to more continuous masses 40 mm. across, with random, irregular sediment-filled lacunae. Calices open upwards. Corallites from 0·3–1·1 mm. in diameter; usually from 0·6–1·0 mm. (average 0·7–0·8 mm.) diameter in mature forms. Outer boundary wall of branch with similar thickness and character to inner corallite wall; no differentiated epitheca. Corallites subquadrate in outline with angular to slightly rounded corners; somewhat thicker walled corallites with more rounded corners. Wall thickness from 0·03–0·1 mm. Well developed septa in mature forms, with axial taper. Occasional tabulae. Patchy preservation of corallites in branches; entire replacement of many branches by calcite.

Remarks: The Fossil Hill species differs from *T. dendroides* from Zeehan in assuming a more variable form, from ramose with linked bundles to tollinoid, irregular with lacunae, lacking an epitheca and having tabulae. It chiefly differs from *T. bowanense* sp. nov., from the lower part of the Bowan Park Limestone in exhibiting larger, connected branches.

T. variabile closely resembles *T. clarki* Okulitch from Lowville strata ("Blackriveran") of Quebec and Ontario in dimensions and tollinoid growth form (Okulitch, 1935; Bassler, 1950) but may be distinguished by being more variable (sometimes exhibiting an ovoid, bundled form) and having tabulae. According to Okulitch (1935) the corallites of *T. clarki* are from 0·75–1·20 mm. in diameter, which suggests that they are on the whole somewhat larger than those in *T. variabile* (0·7–0·8 mm. average diameter) but, on the other hand, Bassler (1950) has stated that the diameter of corallites in *T. clarki* is 0·7 mm.

Tetradium bowanense sp. nov.

Pl. xix, figs. 1–3

Material: 4 specimens (SUP 26270, 29177, 33229, 33237) from the "brachiopod" unit, lower part of the Bowan Park Limestone. SUP 26270 comes from near Quondong, and SUP 29177, 33229 and 33237, from Paling Yards Creek.

Holotype: SUP 26270. Other numbered specimens designated paratypes.

Description: Corallum composed of flattened, irregular, oval to subrounded branches from 1–5 mm. across (usually about 2 mm.). Branches usually with between 4 and 16 corallites; 25 corallites in one larger, incomplete branch. Some branches complete, with outer walls, but most broken and fragmented. Corallites, 0·4–1·0 mm. in diameter; average value for mature forms, 0·6–0·7 mm. Calices open terminally. Wall thickness (inner and outer walls) variable, ranges from 0·03–0·15 mm. (on average 0·1 mm.). Corallites usually with subquadrate outline; some thicker-walled corallites with rounded corners. Rare tabulae.

Remarks: One paratype (SUP 33229) is associated in the same slide with *T. apertum.*

Several specimens from the same horizon and locality as the paratypes exhibit similarities but are differently preserved (Pl. xix, fig. 4). Whereas the type specimens are found in a coarse calcarenite, these specimens occur in interbedded lime muds. They tend to be composed of irregular, rounded to elongate bundles which may be separated or linked, the latter giving a tollinoid habit (with lacunae). The bundles are frequently recrystallized, and are chiefly from 1–4 mm. across. They are tentatively assigned to *T. bowanense.*

Tetradium cribriforme (Etheridge, 1909)

Pl. xvii, figs. 7–12; Pl. xviii, figs. 1–9

1909. *Mitcheldeania* (?) *cribriformis* Etheridge, p. 308, pls. 47–48.

1957. *Tetradium cribriforme* Hill, p. 98, pl. 2, figs. 1–4.

Material: Holotype (Australian Museum — A.M. F13579 and thin section A.M. 817) presumed to come from the "lower coral" unit of the lower part of the Cliefden Caves Limestone at Fossil Hill. Figured specimens (topotypes?) F23221b, F23220c and F23216b, from the same locality and horizon are in the Department of Geology and Mineralogy collections, University of Queensland.

Other specimens from the "lower coral" unit at Fossil Hill are SUP 29146, 29137, 29236–7, 33227 (topotypes?), and from the same horizon near the Boonderoo shearing shed, SUP 29166. SUP 29164 comes from the "upper coral" unit near the Boonderoo shearing shed, SUP 29150–3, 29155–6, 29158, 29163, 33240 from the "Island" unit at the Island, and SUP 28251 from just below the "Island" unit on the banks of Belubula River near the Island. In the Licking Hole Creek area, the lower part of the sequence, probably the "lower coral" unit equivalent, has yielded SUP 29149, 29161–2, 29167, 33236, and the thinly bedded "*Aulopora*" unit in the upper part. SUP 29154.

Material has also been collected from the "pisolite" unit (SUP 26273, 29171) and the "Quondong" unit (SUP 26272, 26274, 29181, 33232) in the middle of the Bowan Park Limestone; from the lower, thinly bedded unit (the "Quondong" equivalent) in the Cargo Creek Limestone (SUP 29160, 29165); from the middle-upper part of the Regan's Creek Limestone (SUP 28159–60); and from the lower part of the Reedy Creek Limestone south of Molong (SUP

33228–9). It also comes from the Reedy Creek Limestone north of Molong and from Ordovician limestone at Billabong Creek, west of Parkes.

Description: Large, hemispherical corallum up to 3 feet (900 mm.) across and more than 12 inches (300 mm.) high; sometimes encrusting (Pl. xviii, fig. 1). Corallites from 0·3–0·8 mm. (average 0·5–0·6 mm.) in diameter. Sediment-filled spaces usually from 0·2–0·3 mm. wide, but some corallites are in contact and other spaced at up to 0·9 mm. apart. Recrystallization of most specimens with consequent loss of internal structures. Some specimens with septa of quadripartite habit and tabulae (Pl. xvii, fig. 10; Pl. xviii, figs. 2–5 and 8–9). Corallites from subquadrate to subrounded in outline; almost in contact, with little associated sediment, or more widely spaced, with lacunae-like spaces, in extremes up to 3 mm. across. Sometimes corallites in contact at corners; sometimes with chain-like (halysitid) pattern. Stellate to lacuna-like openings 1–2 mm. across between linked corallites (Pl. xviii, figs. 6–7) in some specimens from "Quondong" and "pisolite" units. Prominent wavy, cribriform appearance in longitudinal section; alternation between corallites in contact and corallites apart with sediment infill. Break down of walls of corallites in contact seemingly of secondary origin. Supposed connecting tubules only in more recrystallized specimens; no confirmation of connecting tubules in better preserved material. Well developed tabulae in one specimen (Pl. xviii, fig. 4), from 0·2–0·4 mm. apart. Wall of corallite from 0·01–0·05 mm. in thickness. Septa very thin (0·025 mm. wide) and tapering.

Remarks: *T. cribriforme* has a widespread distribution in the Ordovician limestone successions of New South Wales, occurring in both Faunas I and II of Webby (1969). It is perhaps the most common coral in the succession, and forms the largest colonies; the largest are found in the "lower coral" unit of the lower part of the Cliefden Caves Limestone, and in the lower part of the Reedy Creek Limestone north of Molong.

There seems to be little basic morphological difference between the forms occurring in Faunas I and II. It is possible to recognize several different variants. Two varieties have been observed in the Cliefden Caves succession, though the differences may be due in part to different states of preservation. Large colonies of *T. cribriforme* occur in the "lower coral" unit (including the ?topotype material) and the corallites mainly show recrystallized centres and cribriform structure (var. A; see Pl. xvii, figs. 7–10). In the "Island" unit colonies are smaller, seemingly better preserved, and with tabulae showing in some specimens (var. B; see Pl. xviii, figs. 1–5). Different variants have also been recognized in the Bowan Park Limestone. In the "pisolite" and "Quondong" units specimens with relatively small corallites often arranged in chain-like patterns and rounded to stellate-shaped lacunae are exhibited (var. C; see Pl. xviii, figs. 6–7). Another specimen from the "pisolite" unit shows large, mainly isolated, subrounded corallites (var. D; see Pl. xviii, fig. 9).

The type species of *Rhabdotetradium, R. nobile* Sokolov from the Upper Ordovician of the Siberian Platform, is a closely related species to *T. cribriforme*. As diagnosed by Sokolov (1955), and Sokolov and Tesakov (1963), the corallum of *R. nobile* is large and bushy. The corallites are long and have a diameter of from 0·5–0·7 mm.; they may be in contact but are usually spaced between 0·1 and 0·5 mm. apart. The corallites have a quadrate outline with weakly rounded corners. No tabulae have been seen. Septa are short and only appear periodically. Walls are very thin. But for the absence of tabulae and the straight corallites as seen in the longitudinal section of the holotype (rather than a wavy, cribriform appearance), the Russian species would be

conspecific with *T. cribriforme*. Indeed, the recrystallized material figured by Sokolov and Tesakov (1963, Pl. xxi, figs. 6–7) is indistinguishable from *T. cribriforme*.

Tetradium duplex sp. nov.

Pl. xx, figs. 6–9

Material: 3 specimens (SUP 29145, 29238, 34284) from the "lower big shell" unit of Fossil Hill, and 1 specimen (SUP 29168) from a similar horizon near the Boonderoo shearing shed, lower part of the Cliefden Caves Limestone.

Holotype: SUP 29238. Other numbered specimens designated paratypes.

Description: Corallum of slender, subparallel corallites at least 120 mm. across and 60 mm. high. Corallites mainly single; less commonly in contact as paired, or rarely as bundles of three or four; subquadrate outline with rounded corners and moderately thick walls, from 0·7–1·5 mm. (average value of 1·1–1·2 mm. for mature forms). Some corallites with tiny secondary septa (Pl. xx, fig. 7). Primary septa with gradual taper towards axis. Thickness of corallite wall from 0·02–0·10 mm. (usually 0·05–0·07 mm.). No tabulae. Occasionally instead of normal quadripartite division, addition of new corallite in one corner of old corallite by union of two adjacent septa (Pl. xx, fig. 7), and by formation of three new corallites from junction of three septa (Pl. xx, fig. 6).

Remarks: *T. duplex* occurs in close association with *T. variabile* in the "lower big shell" unit at Fossil Hill. In the lower part of the Reedy Creek Limestone north of Molong some rather poorly preserved specimens, tentatively referred to as *T. duplex*, occur with the cerioid *T.* sp. A, and underlie occurrences of *T. cribriforme*, as at Fossil Hill. They differ from the Cliefden type specimens in exhibiting tabulae.

T. duplex somewhat resembles *T. frutex* (Klaamann) from the uppermost Ordovician of Estonia, but this latter species has slightly more rounded corallites, slightly smaller corallites and walls covered by an epitheca (Klaamann, 1966). *T. tubifer* Troedsson from the Upper Ordovician of Greenland also bears similarities but has rounded corallites and thicker walls (Bassler, 1950).

Tetradium cruciforme sp. nov.

Pl. xx, figs. 1–5

Material: 4 specimens from the "mixed fauna" unit of the lower part of the Cliefden Caves Limestone. SUP 34283 comes from north-east of Little Boonderoo, 34282 and 29169 from west of the Boonderoo shearing shed, and 26249 from east of Fossil Hill.

Holotype: SUP 34283. Other Cliefden Caves specimens designated paratypes.

Description: Colony of large, loose, diverging corallites, at least 120 mm. across and 130 mm. high. Corallites rarely in contact except in division; a diameter from 1·0–2·0 mm. (average for mature forms, 1·5 mm.); in outline subrounded to rounded. Wall of corallite rather thick, from 0·1–0·4 mm. (average value 0·2 mm.). Septa with marked taper towards axis. No tabulae. Division seemingly at rather long intervals of several millimetres. One specimen (SUP 34282, Pl. xx, fig. 5) with apparently more frequent division, and slightly thinner, more closely spaced corallites; probably just a local variant.

Remarks: *T. cruciforme* is not closely comparable with any other representative of the *T. syringoporoides* group. It has a larger average corallite diameter (1·5 mm.) than any other representative of this group.

Tetradium apertum Safford, 1856
Pl. xxi, figs. 7–9

1856. *Tetradium apertum* Safford, p. 238.
1869. *Tetradium apertum* var. *apertum* Safford, p. 535.
1950. *Tetradium apertum* Bassler, p. 285, Pl. i, figs. 15–6; Pl. viii, figs. 2–5.
non 1955. *Rhabdotetradium apertum* Sokolov, p. 247, fig. 75.
non 1962. *Rhabdotetradium apertum* Sokolov, p. 253, fig. 67a-b.
non 1963. *Rhabdotetradium apertum* Sokolov and Tesakov, p. 97, figs. 1–2.

Material: 4 specimens (SUP 26269, 29178–80) from the "lithic" unit, lower part of the Bowan Park Limestone at Quondong. Also occurs at the same horizon and from "brachiopod" unit at Paling Yards Creek. In addition, 1 specimen (SUP 33233) from locality north of railway line, east of Gunningbland (and west of Parkes).

Description: Colonies of slender corallites reaching at least 150 mm. across and 90 mm. high. In side view of exterior corallites subparallel with division at long intervals; subquadrate outline, from 0·6–1·2 mm. in diameter (usually 0·8–0·9 mm. in mature forms); corallites usually as single tubes but also as incomplete chains. Sediment spaces (incipient lacunae) between incomplete chains from 2–4 mm. across. Wall usually about 0·05 mm. thick. Septa very slender. Little internal structure with interiors rather recrystallized. One possible tabula. No secondary septa.

Remarks: Apart from the marginally wider spacing of corallites and the possible tabula, the New South Wales species seems to be indistinguishable from *T. apertum* from the Cannon Limestone ("Trentonian") of Tennessee. The apparent secondary septa shown by Bassler (1950, Pl. 1, fig. 15) may represent the start of a new division prior to the completion of earlier division involving the primary septa, and may not therefore represent a fundamental difference from the New South Wales material.

The Russian material referred to *T. apertum* by Sokolov (1955) and Sokolov and Tesakov (1963) must be excluded from the species. It exhibits much closer spacing of corallites (0·1–1·0 mm. apart), slightly smaller average corallite dimensions, and the corallites are characteristically linked by their corners (not by their sides). The Russian species belongs to the *T. cribriforme* group.

Tetradium tenue sp. nov.
Pl. xxi, figs. 1–5

Material: 5 specimens (SUP 26271, 28254, 29170, 33244, 34285) from the "gastropod" unit, lower part of the Bowan Park Limestone near Quondong. Also occurs in the lower part of the *"Ischadites"* unit at Quondong and Paling Yards Creek.

Holotype: SUP 33244. Other numbered specimens designated paratypes.

Description: Corallum of isolated, usually fragmented, slender corallites from 0·8–1·3 mm. in diameter (mature forms average 1·0–1·1 mm.); in extremes with diameter of 2·3 mm. just prior to division. Corallites rarely in contact except at divisions; in outline mainly subrounded, with relatively thick wall, from 0·03–0·20 mm. thick (usually approximately 0·1 mm.). Septa with axial taper. Rare preservation of tabulae.

Remarks: A specimen from the upper part of the Regan's Creek Limestone exhibits a bushy corallum with slender, subrounded corallites from 0·8–1·2 mm. in diameter (Pl. xxi, fig. 6). As seen in hand specimen, the corallites seem to diverge and coalesce along their length. Consequently, in some areas of the

corallum, corallites are in contact and in others they are separated. A few tabulae are seen. Although similar to *T. tenue,* the Regan's Creek species differs in having thinner walls and in exhibiting a clustered form in certain parts of the corallum. It is here referred to as *T.* sp. B and belongs to Fauna II of Webby (1969). Another specimen (SUP 29157) from the *"Aulopora"* unit of the Cliefden caves Limestone near Licking Hole Creek is tentatively assigned to *T.* sp. B. It resembles the Regan's Creek species and occurs at the same horizon, but has a more clustered form and is not particularly well preserved.

Of other species, *T. tenue* is most similar to *T. buttsi* Bassler 1950 from the "Blackriveran" of Virginia. However, it differs principally in having much fewer tabulae and slightly thinner corallites.

Acknowledgements

The authors are grateful to Professor Dorothy Hill (University of Queensland) for reading and offering critical comments on the manuscript, to Dr. G. H. Packham, H. T. Moors, J. G. Byrnes and R. A. McLean for contributing specimens towards this study, and to Mr. L. Frey of Ryde for translations from the Russian. Part of the work was assisted by funds from the Australian Research Grants Committee and a Sydney University Research Grant.

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EXPLANATION OF PLATES

Plate xvii

Figs. 1–3. *Tetradium compactum* Hill from the "brachiopod" unit, lower part of the Bowan Park Limestone, Paling Yards Creek, × 5. 1, SUP 29174, transverse section. 2, SUP 29173, longitudinal section. Note occasional tabulae. 3, SUP 29173, transverse section showing patchy preservation of corallites and the apparent double wall between some corallites.

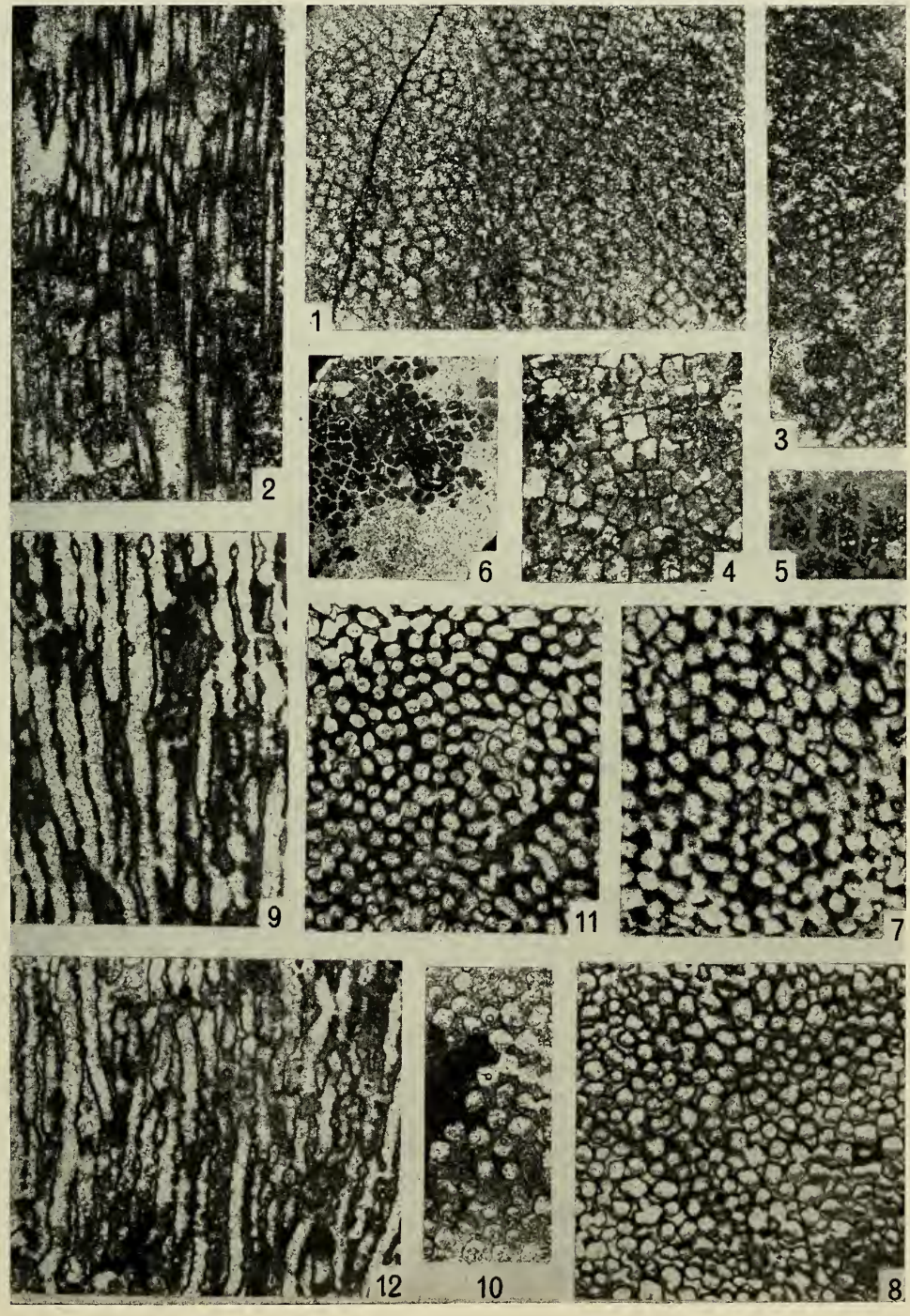
Figs. 4–5. *Tetradium* sp. A, SUP 34279, from lower part of Reedy Creek Limestone north of Molong. 4, transverse section, × 5, transverse section showing detail of primary and secondary septa (photograph of cellulose peel), × 10.

Fig. 6. *Tetradium variabile* sp. nov., SUP 34281, paratype, from the "lower big shell" unit, lower part of the Cliefden Caves Limestone, south-west of Fossil Hill, × 5. Note the irregular lacuna.

Figs. 7–12. *Tetradium cribriforme* (Etheridge), × 5, Fauna I of Webby (1969). 7–8, transverse sections of ?topotypes from the "lower coral" unit, Cliefden Caves Limestone, Fossil Hill. Most corallites are preserved as spar-filled moulds. 7, SUP 29237. 8, SUP 29137. 9–10, longitudinal and transverse sections from the "lower coral" equivalent at Licking Hole Creek, Cliefden Caves Limestone. 9, SUP 29162 showing mainly spar-filled corallites, undulating cribriform appearance and vague, rare tabulae. 10, SUP 29167 exhibiting corallites in contact at their corners and some with wall structure preserved. 11. SUP 33228, transverse section, from lower part of Reedy Creek Limestone south of Molong. 12, SUP 29164, longitudinal section, from "upper coral" unit, Cliefden Caves Limestone, west of Boonderoo shearing shed. Note the mainly spar-filled corallites and prominent undulating cribriform appearance of corallites.

Plate xviii

Figs. 1–9. *Tetradium cribriforme* (Etheridge), Fauna II of Webby (1969). 1–5, from "Island" unit of the Cliefden Caves Limestone at the Island. 1, SUP 29163, × 4, longitudinal section showing colony which has grown over coenosteum of *Ecclimadictyon nestori* Webby. 2, SUP 29150, × 5, transverse section showing corallites with septa. 3, SUP 29153, × 5, transverse section exhibiting some well preserved corallites with septa. Note dasycladacean alga in large sediment-filled space (lower left). 4, SUP 29158, × 5, longitudinal section exhibiting corallites with close-spaced tabulae. 5, SUP 29151, × 5, longitudinal section showing undulating corallites with cribriform appearance and faint tabulae (top left). 6–7, from "Quondong" unit, Bowan Park Limestone, Quondong, × 5. 6, SUP 26272, transverse section showing relatively small corallites with chain-like arrangement and sediment-filled lacunae including a large, stellate-shaped space. 7, SUP 26273, transverse section exhibiting chain-like corallite patterns and rounded to irregular lacunae. 8, SUP 28159, × 5, transverse section, from upper part of Regan's Creek Limestone west of Checkers. Note subquadrate outline of corallites, and preservation of one individual with very thin wall and four septa. 9, SUP 29171, × 5, transverse section, from "pisolite" unit, Bowan Park Limestone, Quondong, showing variable size of corallites including some relatively large subrounded forms. Note very thin walls and septa, and quadripartite division of corallite towards left margin of figure.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